Space Weather Technical Forecast

Issued on Tuesday, 22 March 2022 at 12:40 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight Chance of Minor Geomagnetic Storm G1 to end current UTC working week.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has risen slightly to become Low over the past 24 hours, with occasional small C-class flares peaking in a C1.2 at GOES 16 at 22/1107UTC. This flare appeared to emanate from the newly-numbered AR2974, which dominated in terms of area and complexity. This group remained largely quiet as a Dao/Beta, with only minor trailing spot emergence. The other two spots on the disc were smaller and included centre-disc sunspot region AR2972, which is a consolidating Dro/Beta, while AR2973 faded in the northeast to a unipolar Axx/Alpha.

No Earth-directed CMEs were observed in the period.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, was at largely background levels through the period, however this unexpectedly evolved into a minor coronal hole-like regime in the final hours of the period. The source of this enhancement is not immediately clear, and was absent from recent STEREO A data, however the phi angle appears to be settling on negative at the time of writing (towards the sun), which may hint that CH66/- may be a very belated culprit (now being barely visible near the southwest limb).

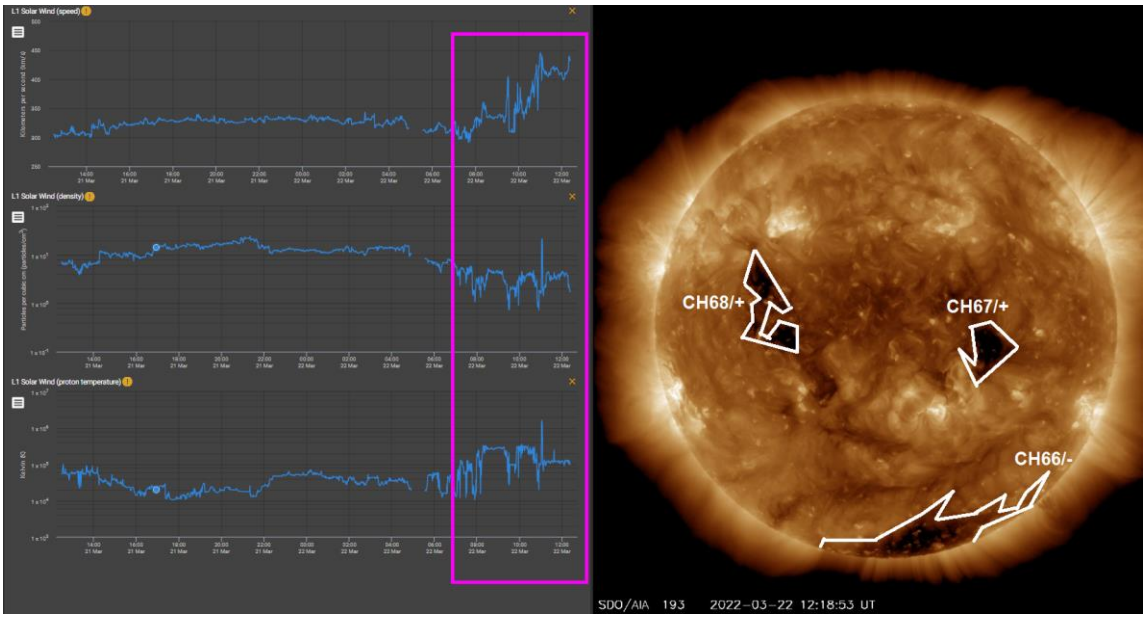

Figure 0: L1 solar wind speed; density and temperature over the past 24 hours, as measured by DSCOVR at L1. Also shown is AIA 193 imagery, with the postulated coronal hole responsible for the observed fast wind (boxed magneta) perhaps CH66/- in the southwest.

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The solar wind speed started the 24 hours near 300km/s, but underwent a sustained increase after 22/1000UTC to reach the low-400s of km/s. This came as the density fell in tandem from around 20ppcc to mid-single figures by the period's end. The IMF peaked at 8nT, with a north-south component range between -6 and +4nT and a somewhat erratic tendency between these limits.

The net result of the above solar wind measures was Quiet geomagnetic activity throughout, with a provisional peak of Kp 2+ in the 03-06UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 showed the tail end of a sub-S1 level enhancement in the period, with this likely to be related to the 21 March far-sided CME event and the Type-II radio burst. Both the 10 and 100MeV traces are now very near typical background levels.

The high energy electron flux (greater than 2 MeV) has been at Normal Background levels, and the 24-hour integrated electron fluence was well below the Active (1e8 integrated pfu) threshold, on a steady trend. Observed fluence at 22/0000UTC was 1.07e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to continue Very Low or Low, with a daily Slight Chance of M-class flares that may increase slightly with time as further regions appear to lie narrowly over the eastern solar horizon.

Solar Wind / Geomagnetic Activity: There is one possible Earth-directed CME in the forecast, potentially giving Earth a glancing blow around 24/2300UTC. There is also one non-persistent coronal hole fast wind due, most likely on Day three (Thursday 24 March). Separately, these events are not likely to be significant, however they may combine to give a peak Slight Chance of G1 on Thursday 24 March, with this risk further decreasing on Friday. Activity should otherwise be mainly Quiet through midweek UTC.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to soon revert to Background levels and remain so for the rest of the four-day forecast period.

The high energy (greater than 2 MeV) electron flux is currently at Normal Background levels, and is unlikely to increase in the near-term. A rise in flux and 24-0hour integrated fluence levels is possible later in the period after the potential CME and coronal hole fast wind arrivals, but this is low confidence. Fluence levels are most likely to stay well below the Active (1e8 integrated pfu) threshold throughout.

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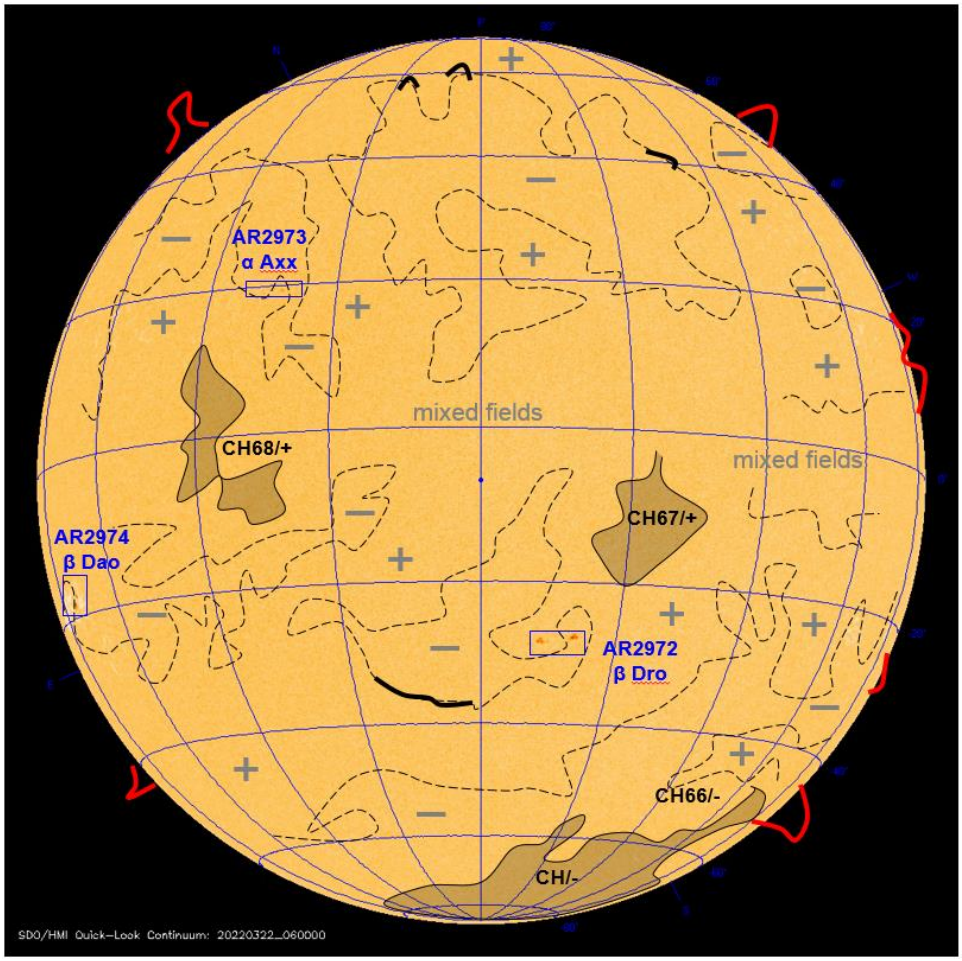
Figure 1. Solar Analysis Valid 22/0600UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Latest measurements from L1 suggest that the fast wind from a minor coronal hole may be starting to affect the near-Earth environment. The phi angle has yet to relaibly settle, however if it remains negative (towards the sun) as it is at the time of writing, the most likely culprit is very belated influence from CH66/-, a minor northward extension from the southern crown. This is not likely to be impactful in terms of geomagnetism, perhaps offering a risk of Active Kp at peak, for being late and therefore slow.

The forecast is otherwise unaltered. There is one possible Earth directed CME in the forecast, associated with the 20/0745UTC C4.6 flare which emerged from the plage remnant of Ex-2971 in the northeast quadrant. This has been assessed in as possibly giving Earth a glancing blow, with this due around 24/2300UTC. No other CMEs feature in the forecast.

There is also one non-persistent coronal hole high speed stream due in the period, most likely on Day three (24 March) - from CH67 west of centre disc. This is both small and of positive polarity, and effects are likely to be muted as positive coronal holes are not favoured for a geomagnetic response at this time of year. However, the combination of the possible CME and coronal hole fast wind may give a slightly enhanced response. STEREO A data appears to be polluted by a passing transient, but so far has failed to hint at the expected character of CH67.

Geomagnetic activity is expected to be mainly Quiet through much of the period, but with an increase possible on Day three, Thursday 24 March, giving a Slight Chance of G1/Minor Storm intervals, this small risk reducing through the final UTC day of the period.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
20/03/2022 22:40	Partial	Plage from Ex-2971	N09 E020	210km/s	24/2300UTC	Slow CME directed towards NE following C4 flare. Most ejecta directed NE of Sun-earth line

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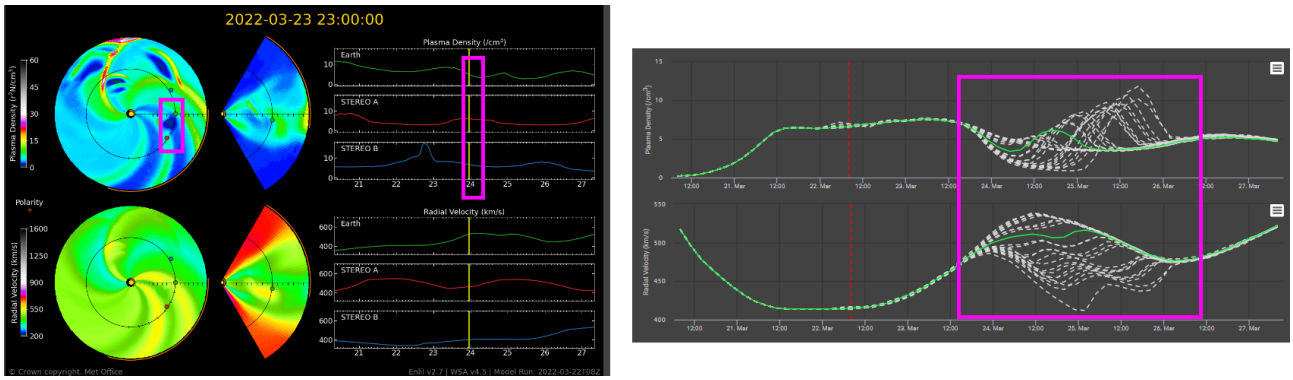
Figure 2: Latest MOSWOC Enlil run, which shows deterministic as a very minor glancing blow around the turn of the UTC day Thursday 24 March into Friday.



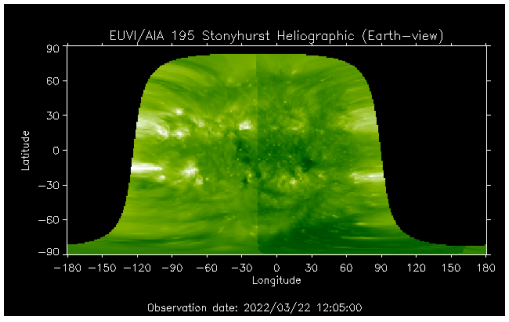
Radio Blackouts - X-Ray Flares:

Solar activity has been Low over the past 24 hours, with the current visible sunspot regions quiet at the present time. The daily probability of M-class flares is judged at a Slight Chance throughout, largely as a result of the appearance of newly-numbered AR2974 in the southeastern quadrant, but this has so far now shown appreciable activity.

There are further potential new sunspot regions due to rotate onto the visible disc in the next couple of days, however their respective contributions to any increase will be more fully accounted for when and if they appear on the Earth-facing side.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	5	5	5
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: Latest extreme-UV cylindrical projection of the sun in 195 Angstroms, showing possible candidates for returning regions narrowly over the eastern solar horizon (when viewed from Earth).



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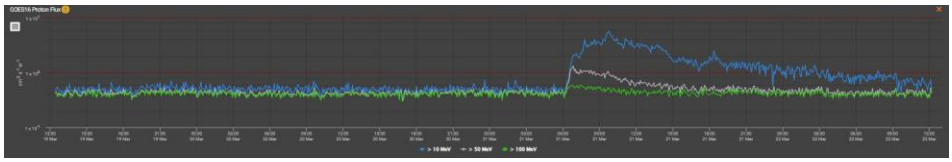
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (10MeV) measured at GOES-16 showed a slight enhancement over the UTC day of 21 March, as a result of a large far-sided CME and probable associated flare. Given a further day's rotation away from Earth of any surviving remnant of the (unknown) source region, the chances of repeats of such events are now considered very low and solar radiation storms are therefore not expected.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Past three days in GOES 16 high energy proton flux, showing the sub-S1 response to the 21/0545UTC CME and flare on the far side. Levels are now narrowly above typical background and should further decay in the coming 24 hours or so.



High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux as observed at GEO by GOES-16 is currently at Normal Background levels, with any significant enhancement in the near-term unlikely.

The next potential enhancement may come from CH67/+, which is due to arrive on Day three (Thursday 24 March), once initial CIR effects have waned. However, this feature is expected to be weak with little geomagnetic response, so is unlikely to raise electron levels enough to reach the Active (1e8 integrated pfu) fluence threshold in the forecast period. The general trend on MOSWOC REFM is currently flat and well below Active, with this accepted.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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